February 15, 2016

Dr. Andrew Rawicz

School of Engineering Science

Simon Fraser University

Burnaby, BC, V5A 1S6

Re: ENSC 440W Function Specification for WizardHand controller system

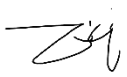
Dear Dr. Rawicz,

The following document, a function specification for WizardHand controller system, describes our project for ENSC 440. This project will provide an alternative solution to cursor control on the PC screen with mobility and no requirement of a flat surface.

This function specification will exhibit detailed design goals and technologies in order to achieve them. It will also include consideration of sustainability and safety issues related to this product. Our dedicated development team will follow this document as guild lines to complete this brilliant project.

AimBot Technology is established by four talented and enthusiastic engineering students: Alex Chen, Albert Xu, Current Zeng, and Scott Zhu. We are looking forward to solving your questions and concerns about our project via ziqic@sfu.ca.

Sincerely,



Alex Chen

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Functional Specification for the Wearable Pointing Device

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Submitted to: Dr. Andrew Rawicz – ENSC 440
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Executive Summary

Mice have been the dominating controlling method of cursor for decades. No matter it is wired or wireless, and no matter it uses an optical sensor or laser sensor, there is an unchangeable limitation: A flat and stable surface is needed. With the rapid development of personal computers, this limitation is causing a headache to considerable of users. Nowadays, our monitors are transforming into several of forms: Projectors, TVs, Glasses, Smartphones, and watches. A major number of them involve a relatively long distance between users and screens or un-reachable scenario. Thus, the touch screen solution will either be too expensive or impossible.

The proposed device, WizardHand, can be wirelessly connected to PCs and smartphones in order to achieve cursor control. It is wearable as it is a glove, and it will not be limited by the existence of a table since it maps the location of a single hand directly to the screen. It uses the combination of finger positions to launch hotkeys which is intuitive and fast. By using this device, the user will have a more elegant and efficient way to control the screen while doing a presentation, and a more involving and attractive experience during gaming. It will be compatible with Android device in the future upgrades as an essential accessory to Google Cardboard VR.

This document lists all the functional requirements as well as engineering standards for the overall system design of the WizardHand. Sustainability of the device material and electronic components will also be discussed. The requirements will be given a priority level based on the stage of development. The overall system will be discussed in the following sections of the document:

- System Overview - General system requirements and engineering standards.
- Requirements – System, Electronics, Glove, Software.
- Safety and sustainability analysis.

AimBot technology plans to finish a prototype of WizardHand which follows all the requirements and standards in this document, and we believe it will bring exciting new experience to the peripherals' market.

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Glossary

IMU	Inertia Measurement Unit
Wi-Fi	Local area wireless computer networking technology that allows electronic devices to connect to the network
Membrane Potentiometer	Three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider in form of Membrane
Quaternion	Number system that extends the complex numbers
Bluetooth	Wireless technology standard for exchanging data over short distances

v

1. Introduction

The WizardHand Controller System is a wearable pointing device which designed to help people achieving cursor control in a more elegant and efficient way while giving a presentation or playing video games. The system contains a combination of finger positions to launch hotkeys which are intuitive and fast. This functional specification document will outline the requirements for the WizardHand Controller System as proposed by AimBot Technology.

1.1 Scope

In this document, all the functional requirements for both hardware and software components will be clearly described. These functional requirements along with safety and engineering standards will act as the roadmap for the proof-of-concept of the WizardHand Controller System and will also help us to deliver the final product successfully.

1.2 Intended Audience

This document is intended to be used as a guideline for company members who is designing and developing the product. It shall also assist in creating a testing plan which will ensure that the delivered product meets the requirements for customers to use.

1.3 Classification

The requirements stated throughout the functional specification will follow the convention

[Rx.y.z-w]

where x is a number that denotes the requirement group, y is a number that denotes the subgroup, z is a number that denotes the subgroup requirement number, and w is a letter that indicates the priority such that:

P	The requirement applies to the proof-of-concept system only.
O	The requirement applies to the ongoing development stage.
F	The requirement applies to the final production system only.

2. System Overview

2.1 System Specification

Figure 1 shows the basic procedure how information is being processed. Microprocessor collect raw data from the Inertia Measurement Units (IMU) and membrane potentiometer, then send the data to PC through Bluetooth. After receiving data, our device driver will do calculations to transform orientation data to cursor position and map hand gesture into mouse functions and hotkeys. There are two measurement aspects in our design, hand gesture, and hand orientation. We predict hand orientation by processing IMU data and record hand gestures by using membrane potentiometers. In addition, we collect all of the IMU and membrane potentiometers raw data by the processor without doing any calculation. After collecting data, the information is sent to PC software by Bluetooth. At last, the cursor position is based on the calculation result from IMU and mouse functions and hotkeys are transformed by the combination data from five membrane potentiometers.

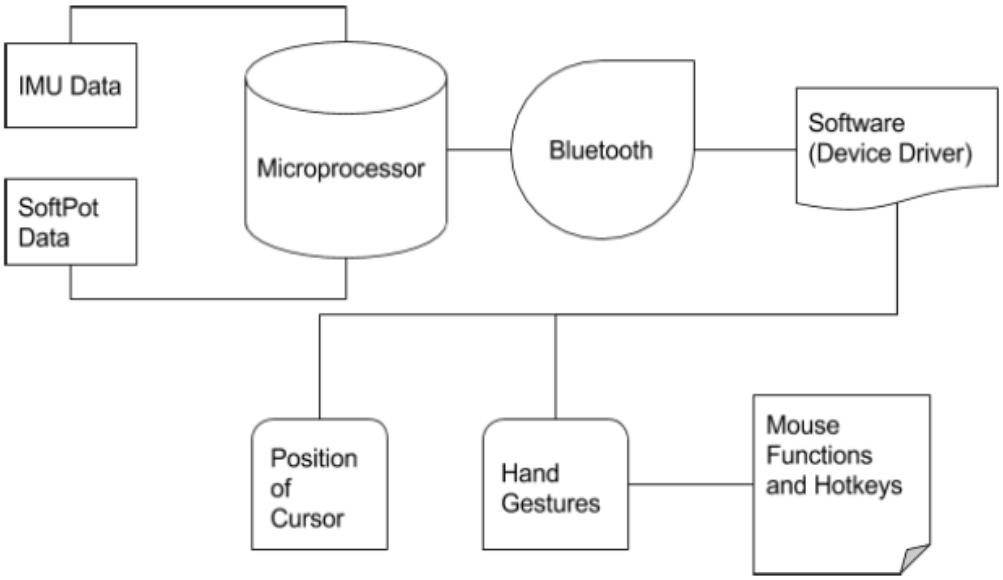

Figure 1. System Specification

2.2 User Interface System

In our software, the user interface layout will be similar to Figure 2. After recording users' hand gestures, the user can decide what function or hotkey that hand gesture has. After recording all hand gestures the user want, the software can run in the background if the user needs.

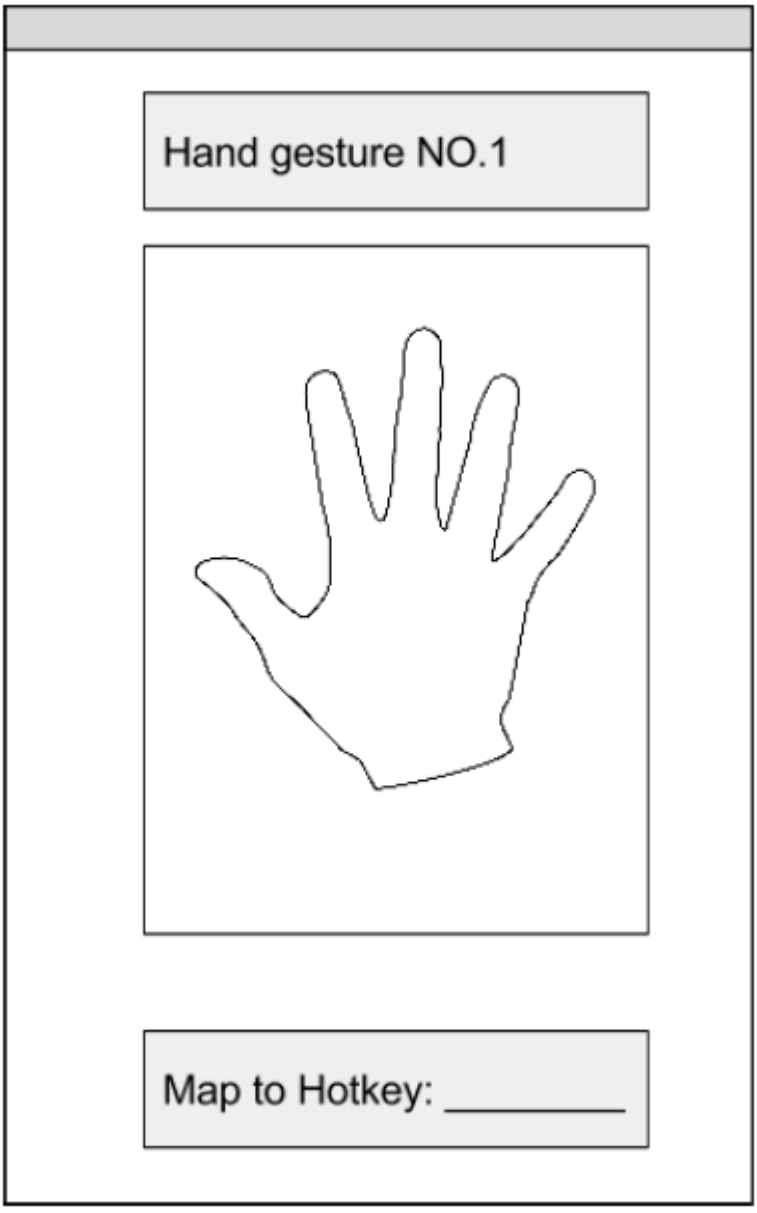

Figure 2. User Interface

2.3 Functionality Justification

The function of the WizardHand Controller System would allow users to customize hand gestures to hotkeys. Such a device can be used for three main purposes. First, entertainment purpose, if a user is playing first-person shooter (FPS) games, he/she can use this device for a more intuitive and realistic gaming experience. Second, presentation purpose, the user can point and drag objects and flip pages of PowerPoints when he/she is giving a presentation. Last, common pointing purpose, the user can use our device when he/she is editing text files or doing Photoshop by using customized hotkeys. It is a more efficient way because hand gestures are more natural and easier to do than typing hotkeys. To achieve these properties, we chose the following components to satisfy these goals: Flexible potential meter, Bluetooth module, IMU, and Arduino Pro-Mini. The use of flexible potential meter will measure the curvature of each finger and return a signal representation. Using Bluetooth to build a serial communication with our product is much easier than using Wi-Fi connection, and it will not rely on any third party to build the connection. The purpose of using IMU is to predict hand gesture. The most important part is Arduino Pro-Mini. Firstly, it is an open source platform and it is using C++ to the program, so it is easy for us to learn and get hands on. Secondly, Arduino Pro-Mini is thin enough to be mounted on a wearable device. Lastly, Arduino Pro-Mini has TR/RX (transfer and receive) pins to connect with Bluetooth module, which satisfies our design requirements.

With our market research, there are some wireless pointing devices already in the market. But they are in forms of either the TV controller or the band and do not have hotkey functions. Our product is way more convenient to take and has more functionalities, which makes it a bright future in the market.

2.4 Current Constraints

The main constraint in completing this project is the modules arrangement on the glove. Since the company is at the prototyping stage, we have to use the ready-made modules to build our project. To build this project, four modules will be involved. They are the microprocessor, Bluetooth module, IMU breakout board, and membrane potentiometer. Since the idea is to build a light and thin wearable device, it is a challenge for our team to arrange all modules on

a glove to keep it both comfortable to wear and efficient to use. If the company grow up in the future, we can design our own PCB boards and use professional soldering machine to solder smaller components on our products to make it thinner. There may be some financial constraints since it is the first time we are constructing this product, some of the electronics components might be broken during the assembling process, so we may need more budget than we have right now.

3. Requirements

3.1 System Requirements

This section lists the general requirements applicable to the WizardHand as a rehabilitation system.

3.1.1 General Requirements

[R1.1.1 - F] The system will have a switch to turn the device on and off.

[R1.1.2 - P] The system will consume zero power when turned off.

[R1.1.3 - F] The retail price of the device shall be under $300.

[R1.1.4 - P] The system shall be easy for anyone to operate.

3.1.2 Environment Requirements

[R1.2.1 - F] The device shall be used only in an indoor environment.

[R1.2.2 - F] The device require the PC ends to have Bluetooth adapter.

[R1.2.3 - O] The device shall be operated at a temperature of -40°C to +85°C to ensure IMU[1] measuring correct data.

3.1.3 Standards

[R1.3.1 -F] The device shall conform to “Standard for Wearable Consumer Electronic Devices” IEEE – P360.

[R1.3.2- F] The device will be in compliance with FCC Title 47 Part 15 Subpart B standards for unintentional radiators.

[R1.3.3- F] The device will be in compliance with CAN/CSA-C22.2 NO. 0.12-M1985 standards for wire spacing and bending.

[R1.3.4- F] The device will be in compliance with CAN/CSA-C22.2 NO. 0-10 (R2015) standards for wire insulation.

[R1.3.5- F] The device manufacturing process will be in compliance IS0 9001 standards for quality management.

[R1.3.6- F] The device manufacturing process will be in compliance IS0 14001 standards for environmental management.

[R1.3.7- F] The device will be in compliance with WEEE (Directive 2012/19/EU) standards regulating electrical and electronic waste.

[R1.3.8- F] The device will be in compliance with RoHS (Directive 2002/95/EC) standards for the reduction of environmental pollutants.

3.1.4 Reliability and Durability

[R1.4.1 - F] All components of the device shall be able to withstand regular use.

[R1.4.2 - F] The device shall be serviceable by trained technicians.

[R1.4.3 - O] The device shall not be exposed to any liquid immersion.

3.1.5 Safety Requirements

[R1.5.1 - F] The device shall not cause physically harm to the user for any time.

[R1.5.2 - F] The device shall not spontaneously combust while charging.

[R1.5.3 - O] All electronic components and wiring shall be enclosed.

[R1.5.4 - P] All electronic components and wiring shall not interfere with any other devices.

3.1.6 Performance Requirements

[R1.6.1 - O] The device shall be operated within 9m (30ft) to ensure proper Bluetooth connection.

[R1.6.2 - O] The device works the best for average hand size user.

3.1.7 Usability Requirements

[R1.7.1 - F] The device need to record IMU data at an initial state.

[R1.7.2 - O] The device shall provide vibrate feedback when the hotkeys are triggered.

[R1.7.3 - O] The weight of the device shall not exceed 0.3kg to ensure comfortable wearing experience.

[R1.7.4 - F] The device’s temperature shall not be over +30°C while in use.

[R1.7.5 - O] The firmware of the device will be updated via USB cable.

3.2 Electronic Requirements

This section lists the requirements for the WizardHand Electronics subsystem, including IMU, Bluetooth, Membrane potentiometers, Vibration motor, wiring, and junctions.

i. General Requirements

[R2.1.1 - O] Raw sensor date will transfer from the glove to Software via the microprocessor and Bluetooth module.

[R2.1.2 - O] Each Membrane potentiometer will be attached to inner side of the glove finger.

[R2.1.3 - O] The combination of 5 Membrane potentiometers shall provide maximum 32 hotkeys and mouse functions.

[R2.1.4 - F] The battery shall be replaceable and rechargeable.

[R2.1.5 - F] The device shall have LEDs to indicate power status.

[R2.1.6 - F] The device shall have LEDs to indicate each finger's status.

[R2.1.7 - F] The device shall have LEDs to indicate Bluetooth connection.

[R2.1.8 - O] IMU [1] will operate at 2.375 - 3.465V.

[R2.1.9 - O] Bluetooth [3] module will operate at 3.0 - 4.2V.

[R2.1.10 - O] Microprocessor [4] will operate at 6-12V.

[R2.1.11 - O] The Membrane Potentiometers shall have resistance [3] of 1 - 10 KΩ.

[R2.1.12 - O] The device shall be able to operate at full capacity for a minimum of 2Hr.

[R2.1.13 - F] The Li-on battery thickness shall not exceed 8mm.

[R2.1.14 - P] The electronics shall be minimally intrusive to the user.

[R2.1.15 - P] The device will have a switch for Bluetooth programming purpose.

[R2.1.16 - P] All sensor data shall not be processed in the microprocessor to ensure maximum data exchange rate.

[R2.1.17 - F] The power source shall be sufficient for all electronics simultaneously.

[R2.1.18 - O] The measurement error of Gyroscope [1] shall be under 1.8% for each axis.

[R2.1.19 - O] The maximum measurement error of Accelerometer [1] shall be under 4% for each axis.

[R2.1.20 - O] The maximum measurement error of Magnetometer [1] shall be under 4% for each axis.

ii. Physical Requirements

[R2.2.1 - F] The device components will be connected by the stainless conductive thread.

[R2.2.2 - F] The glove shall have at least 2 layers to prevent the device components from interfering with user's hand.

[R2.2.3 - F] IMU will be mounted near wrist to reduce noise from subtle hand movement.

[R2.2.4 - O] All components (exclusive of membrane potentiometers) shall be mounted on the back of the glove.

3.3 Glove Requirements

This section lists the requirements for the WizardHand Glove enclosures.

3.3.1 General Requirements

[R3.1.1 - P] The material of the glove shall be soft and comfortable to wear.

[R3.1.2 - P] The glove shall have two layers, inner cloth only cell and outer electronics carrier.

[R3.1.3 - P] The inner cell shall be replaceable and washable.

[R3.1.4 - P] The material of the glove shall be resilient.

3.3.2 Physical Requirements

[R3.2.1 - P] The outer electronics thickness shall not exceed 1cm.

[R3.2.2 - F] The glove shall withstand with regular use and stretch.

3.4 Software Requirements

This section lists the requirements for the WizardHand Software system, including Noise Reduction and Analytic Algorithm.

3.4.1 General Requirements

[R4.1.1 - F] The software shall be open and closed by the user.

[R4.1.2 - F] The software will tell the user to keep his/her hand steady when calibrating at the initial state.

[R4.1.3 - P] The software shall show pictures of hand gestures when the user is customizing hotkeys and mouse functions.

[R4.1.4 - F] The software shall have a drop-down menu to select hotkeys and mouse functions when the user is customizing hand gestures.

[R4.1.5 - P] The customized profiles shall be saved once it is finished.

[R4.1.6 - P] The customized profiles will be always available for the user to edit.

[R4.1.7 - O] The user interface will have three tabs.

[R4.1.8 - O] The first tab will show connection status and the device name.

[R4.1.9 - O] The second tab is an IMU calibrating interface.

[R4.1.10 - O] The last tab is the interface for the user to customize his/her hand gestures.

[R4.1.11 - P] The user interface shall be colorless and easy to operate.

[R4.1.12 - O] The number of clickable buttons in each tab shall not exceed 4.

3.4.2 Physical Requirements

[R4.2.1 - F] If user's PC does not have built-in Bluetooth adapter, then he/she may have purchase a USB external Bluetooth adapter.

[R4.2.2 - O] The software will be made available via portable devices.

[R4.2.3 - O] The software will be made available via digital download.

3.5 User Documentation

This section lists the requirements for the WizardHand user documentation.

[R5.1.1 - F] The user documentation shall include a website with a detailed guide on finding general and technical information about this device as well as a user manual, both written in English.

[R5.1.2 - F] The user documentation shall be translated in multiple languages according to the territorial adoption, and printed all in one paper.

[R5.1.3 -F] The pre-programmed gestures and re-program method shall be provided.

[R5.1.4 - F] The user documentation will also include battery recycle notice, warning, and contact information.

4. Safety and sustainability analysis

The purpose of our product is to make a mouse wearable and portable, so extensive measurement and the test must be taken in order to make sure that our product will not harm or injury the users since it will attach their skin. While picking electronic components, we are keeping in mind that the device is in close contact with the user. The placement of the wiring and other pieces in the glove are carefully thought out to avoid any disturbance to the users.

From the early planning, we have considered integrating existing parts and components as well as recyclable materials. One of the focal issues is the use of batteries in the design. An improvement will be made in production by replacing the disposable power source with rechargeable batteries instead. Many of the components such as sensors and controllers purchased for this project can be used again in the future prototypes and designs. The cradle-to-cradle design approach is on the agenda for the production phase and the appropriate certifications will be attained.

5. Conclusion

This functional specification briefly defines the design requirements of the WizardHand. For each subsystem requirement and requirements for the system as a whole, priority is based on the safety and functionality of the final product. Development of the proof-of-concept model has already begun, and all features are expected to be fully functional by the target date of April 15th, 2016.

6. References

[1] InvenSence Inc. (2013 September 18th). MPU-9150 Product Specification (Revision 4.3). [PDF File]. Available: https://cdn.sparkfun.com/datasheets/Sensors/IMU/MPU-9150-Datasheet.pdf

[2] Guangzhou HC Information Technology Co., Ltd. (2011 March 6th). HC-06 Product Data Sheet (Rev2.2) [PDF File]. Available: https://www.olimex.com/Products/Components/RF/BLUETOOTH-SERIAL-HC-06/resources/hc06.pdf

[3] Spectra Symbol Co. Datasheet of Membrane Potentiometer. [PDF File]. Available: https://www.sparkfun.com/datasheets/Sensors/Flex/SoftPot-Datasheet.pdf

[4] Sparkfun. Arduino-Pro-Mini Graphical Datasheet. [PDF File]. Available: https://cdn.sparkfun.com/datasheets/Dev/Arduino/Boards/ProMini16MHzv1.pdf